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DUAL AXIS SOLAR TRACKING SYSTEM WITH WEATHER AND POWER MONITORING SYSTEM

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***ABSTRACT*-The implementation of a simple dual-axis solar tracker system is a key component in harnessing the maximum potential of solar power, which is currently the fastest-growing means of renewable energy. By introducing solar tracking systems into solar power systems, energy generation can be significantly optimized. The dual-axis tracker allows for efficient tracking of sun rays by enabling the solar panel to rotate in all directions. Additionally, this solar tracker project offers the capability to sense weather conditions, which can be displayed on an LCD screen. The system utilizes an Arduino microcontroller as its power source and integrates key components including a servo motor, regular motor, sensor, temperature and humidity sensor, and power sensing capability.**

KEYWORDS: Arduino UNO, Dual Axis, Stepper Motor, LDR Sensors, Temperature Sensor, DTH 11 Sensor, Current Sensor, Voltage Sensor.

I. Introduction

The growing requirement for dependable and plentiful energy sources has highlighted the importance of transitioning towards renewable sources such as solar and wind power, thereby diminishing reliance on non-renewable alternatives.The government has actively encouraged the adoption of renewable energy, particularly solar power, which is considered a valuable resource. To generate electricity effectively, solar panels should ideally be perpendicular to the sun's rays, as any deviation from this angle can result in reduced electricity generation. Solar tracking, particularly using dual-axis systems, has emerged as one of the best methods for maximizing electricity generation from solar power, leveraging its renewable nature. Comparatively, fixed solar panels and single-axis tracking systems are less efficient. The dual-axis system, which combines both vertical and horizontal movement, has been found to increase electricity generation by 38%. Additionally, this system can be utilized for weather monitoring purposes.

In this project, a dual-axis sun tracker is integrated with a weather sensors. Sensors are employed to detect temperature, raindrop, and humidity, with the output displayed on an LCD screen. Light detecting resistors (LDRs) sense the high intensity of sun rays, guiding the rotation of servomotors towards this intensity using an Arduino. The servomotors are responsible for rotating the solar panel, while the sensors provide information on weather conditions. Throughout countless millennia, humanity has progressively depended on energy for survival and prosperity. Solar energy emerges as a promising remedy, presenting itself as a trustworthy and environmentally friendly source, free from pollution. Therefore, maximizing energy generation through efficient methods like solar tracking proves to be beneficial and effective.

II. Literature survey

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1. Arduino Based Dual Axis Solar Tracking System

The growing global concern regarding non-renewable energy sources and ozone-depleting emissions has led to intensified research and development in alternative energy solutions. The significant growth of photovoltaic energy production showcases the potential of renewable energy. Nevertheless, the efficiency of photovoltaic conversion is influenced by the daily and seasonal movements of the sun, which directly affects the intensity and duration of solar illumination. To address this, a low-cost, low-power dual-axis solar tracker (DAST) has been developed to optimize energy production. The DAST project encompasses the design, construction, and assembly of mechanical structures, electrical systems, and devices. The control logic responsible for positioning the solar module to maximize solar illumination is also detailed. Light Detecting Resistors (LDR) sensors play a vital role by providing input signals to a microcontroller. This enables automatic rotation of the PV panel to track the sun's irradiance throughout the day. To protect the mechanical structure from adverse weather conditions, the panel remains in a horizontal position at night.

In addition, the proposed system integrates a 12V battery charging system that powers both module movement and electronic devices. The implementation of the designed DAST has shown promising results, reducing the payback period of a single PV installation by 8% compared to a fixed structure. These findings are based on the solar irradiance available in the Serra Gaucha region of South Brazil.

2. Design Of Intelligent Tracking System

Solar panels absorb sunlight and convert it to electricity, making them the future of renewable energy. A solar panel is made up of solar (or PV) cells that can be utilized to produce electricity using the effect of PV. Photovoltaic simply means that they turn sunlight into electricity. Solar panels are classified into three categories: monocrystalline and thin film. Each kind of solar panel has its own set of benefits and drawbacks, with polycrystalline panels being low-cost and low performance, mono-crystalline panels being high-cost and high-efficiency, and panels of the thin film being portable and versatile but having the lowest efficiency. Solar panels have a lot of benefits, including the ability to last up to 40 years, the use of the most abundant resource, sunshine, and the fact that they are both cheaper and more environmentally friendly than fossil fuels. Solar power is the most rapidly expanding energy source. This project's main aim is to create a highly accurate solar tracker. There are two parts to the project: hardware and software. Solar plate, DC motors with operating boxes, LDR (Light-dependent resistor) sensor, and electronic components circuit make up the hardware component. The software component reflects the system's thought actions, or how it behaves under various weather conditions. A solar tracker system with having dual-axis was used to design and execute the project. Devices that monitor solar energy must be used in solar power systems to optimize the energy output from the sun. Energy can be used by using dual-axis trackers as they monitor sun rays from solar panels that are switched in different directions. This solar panel can rotate in any direction. Our project is also designed to detect whether changes. The motors, sensors i.e., rain and temperature sensor, display are all operated by Arduino.

III. Objective

The objective of a dual-axis solar tracking system with weather and power monitoring is to maximize the efficiency and output of a solar power system by continuously adjusting the position of the solar panels based on the sun's position and environmental conditions. The system tracks the sun's movement in both the azimuth (horizontal) and altitude (vertical) axes, ensuring that the solar panels are always perpendicular to the sun's rays, thereby maximizing the amount of solar energy captured.

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In addition to the dual-axis tracking functionality, the system also incorporates weather and power monitoring capabilities. By combining dual-axis solar tracking with weather and power monitoring, the objective is to enhance the overall performance, reliability, and energy yield of the solar power system.

IV. Block Diagram

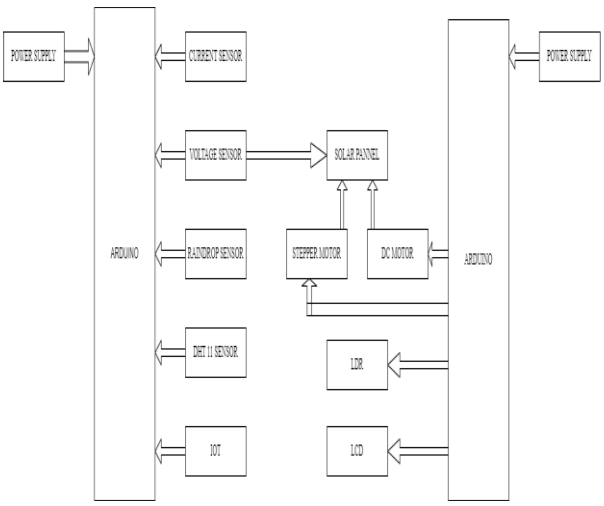

Fig : Block Diagram

V. Proposed System

The light detecting unit comprises four light detecting resistors (LDRs) organized in pairs, enabling the measurement of light intensity and its conversion into analog voltage. These LDR pairs serve as inputs to the controller, with one pair monitoring the sun's position in the east-west direction and the other pair in the north-south direction. The LDRs exhibit a resistance that varies inversely with light intensity, following the equation RL = 500/LUX. The Arduino serves as the main control unit, with the LDRs connected to its first four pins (A0-A4). By processing the LDR inputs, the Arduino sends instructions to the servo motors, enabling rotational movement in either the horizontal or vertical directions.

To optimize power consumption, only one motor operates at a time. Additionally, the setup includes a weather sensing unit and power sensing unit, with the Arduino acting as the interface. It enables the measurement and display of surrounding temperature conditions and power output on an LCD display device.

VI. Working

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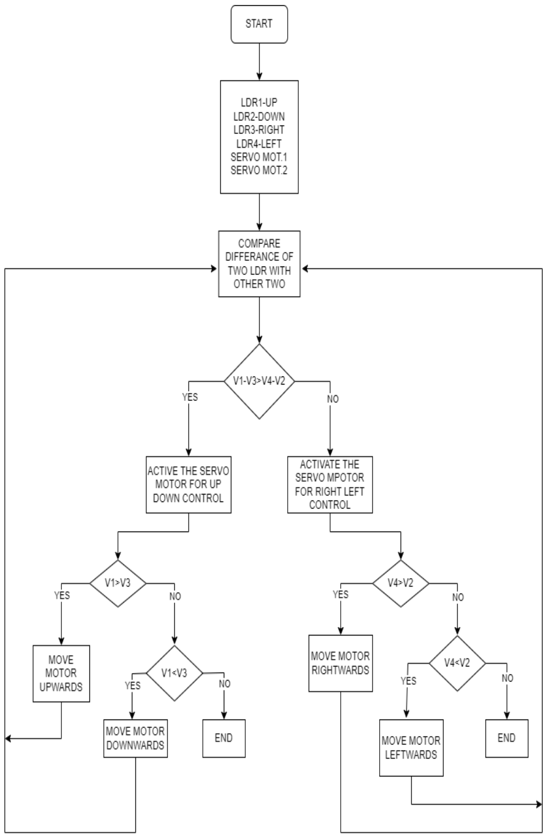

FIG : Flow chart of solar tracking system

VII. Results

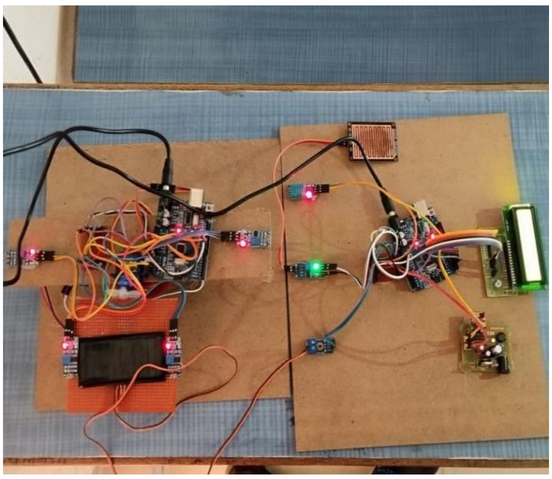

FIG : Circuit Connections

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FIG : Weather and power monitoring graphs

VIII. Conclusion

The paper presents a solution for tracking the sun's position using Arduino MEGA and LDR sensors. The goal is to maximize the energy output of solar cells by positioning a solar panel at the point of maximum sunlight intensity. The designed solar tracker offers a simple mechanism to control the system and can initialize its starting position without the need for additional photo resistors. The significance of this solar tracker lies in its ability to improve efficiency. As renewable energy production becomes more widespread, even a small increase in efficiency, such as 1% compared to a stationary solar panel, can result in a significant boost in power production. Therefore, any improvement in efficiency is highly valuable.

In conclusion, this mechanism can find applications in various solar tracking systems, including parabolic flat plate collectors, solar dishes, lenses, and other photovoltaic (PV) systems. Its purpose is to maximize the collection of solar radiation and can be utilized in a wide range of contexts.

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IX. Future Scope

To further enhance the efficiency of the dual-axis tracking system, incorporating a mirror or concave lens on top of the solar panel can be beneficial. This addition concentrates a larger amount of sunlight onto the panel, resulting in increased power generation. Additionally, it allows for a reduction in the size of the required solar cell while maintaining high optical efficiency.

India, with its favourable geographical conditions and abundant solar radiation throughout the year, holds significant potential for the generation of solar energy. Solar plants offer the advantage of being environmentally friendly, as they produce no pollution or greenhouse gases. Therefore, they are considered a clean and sustainable source of energy. Furthermore, reducing the cost of materials used in solar panel manufacturing, such as silver and silicone, would contribute to overall cost reduction. Despite on-going developments, the solar energy industry still faces challenges related to cost, operational efficiency, and feasibility demands. Addressing these issues is crucial to further enhance the widespread adoption of solar power.

X. References

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